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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G07D 7/00	A1	(11) International Publication Number: WO 97/01156 (43) International Publication Date: 9 January 1997 (09.01.97)

(21) International Application Number: PCT/GB96/01469

(22) International Filing Date: 19 June 1996 (19.06.96)

(30) Priority Data:
9512698.3 22 June 1995 (22.06.95) GB

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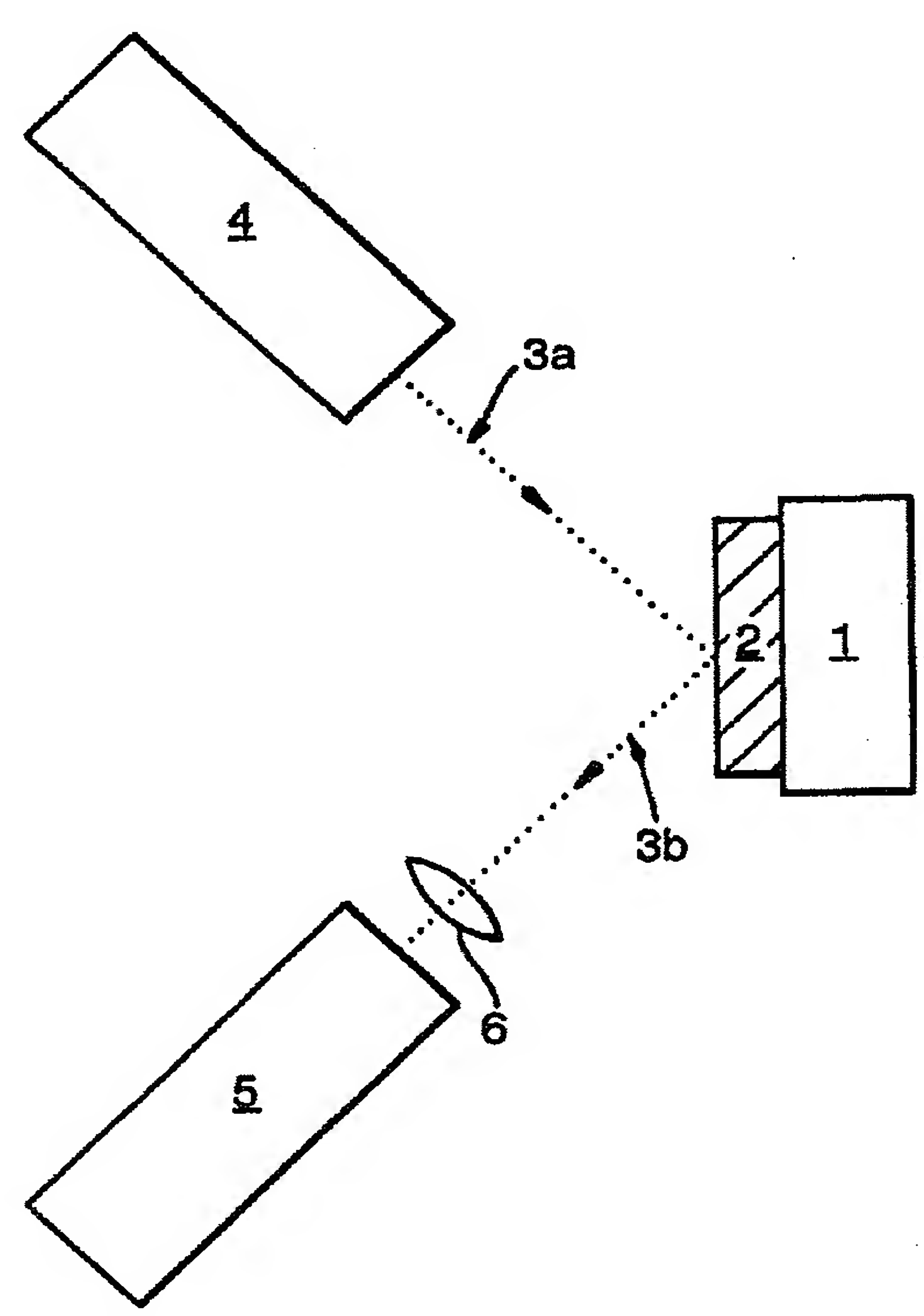
(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: ANTICOUNTERFEITING METHOD

(57) Abstract

A covert method of distinguishing between genuine and counterfeit articles by means of applying an optical filter to genuine articles as a mark of authenticity. The filter for use in the method may comprise a multi layer stack having at least one maximum and at least one minimum in the spectral characteristic and a selective absorber over a range of visible wavelengths. The spectral characteristic is such that the filter has a neutral appearance when viewed by an unaided eye under normal lighting conditions, but gives rise to characteristic optical effects when illuminated with selected wavelengths. The characteristic effects provide an authenticating signature for the filter. In the absence of the filter, the illumination would not give rise to the characteristic effects. The intensity of radiation reflected or transmitted by the filter at two or more wavelengths may be used to provide the authenticating characteristic. In an alternative embodiment, the filter may be illuminated with radiation at two or more angles of incidence. The resulting intensity or spatial distribution of radiation reflected or transmitted by the filter may be used to verify the authenticity of the article by comparing the observed properties with known properties for the filter.



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ANTICOUNTERFEITING METHOD

This invention provides a means of identifying genuine and counterfeit articles and lends itself to covert operation. It has particular (although not exclusive) relevance to the retail trade.

Counterfeiting of articles is a long standing international problem in, for example, the retail trade and credit card industry and the need for an effective means of combating counterfeiting has attracted considerable attention. One technique for indicating the authenticity of a particular article is by the use of a trademark. Such trademarks are becoming increasingly complex in design incorporating, for example, optical effects such as holograms and diffraction patterns. However, large scale counterfeiting organisations have access to considerable resources and are becoming increasingly successful at copying even the most complex marks.

The use of infrared technology in anticounterfeiting systems has already been established. For example, GB2284292 relates to a covert marking system in which genuine articles are endowed with a label whose appearance is very different when scanned using equipment which is sensitive to radiation in the near infrared region of the electromagnetic spectrum. In another example (patent application WO 91/08556) the presence of infrared absorptive materials can be detected by illumination at wavelengths close to the absorption peak and processing the detected signals to derive a signal characteristic of the absorbing species. Similarly, GB 2190996A relates to a technique for authenticating articles by determining the characteristics of the envelope of single fluorescence, phosphorescence or absorption bands.

Another example of a covert anticounterfeiting system, UK patent application GB9409128.7, relates to a system for distinguishing between genuine and counterfeit articles where the apparatus comprises of a first optical filter which is applied to the genuine article and a second optical filter which is used for scanning purposes. The scanning of the genuine articles with the aid of the second optical filter gives rise to optical effects which would not otherwise be apparent.

The present invention extends these concepts to the use of an optical filter and a radiation source. When observed under normal lighting conditions the filter has a neutral appearance, but when illuminated with radiation of selected wavelength components, gives rise to optical effects which would not be present in the absence of the filter or without use of the correct illuminating radiation. The system is effective under normal lighting conditions and has the advantage that it may be operated covertly. It has the advantage that although the counterfeiter may be aware of its use, the labels applied to the genuine articles may be changed regularly or used in association with barcodes.

Throughout this specification, the use of the word "article" or "articles" should be taken to relate to the said article or articles or the associated packaging or wrapping.

According to one aspect of the invention, a method for covertly marking an article and checking its authenticity comprises the steps of:-

(i) applying an optical filter to a genuine article, wherein said filter has a spectral characteristic comprising at least one maximum and at least one minimum and has a neutral appearance when observed under normal lighting conditions,

(ii) illuminating the article to be authenticated with electromagnetic radiation comprising components of at least two wavelengths,

(iii) upon said illumination, detecting radiation reflected or transmitted by the article to be authenticated and

(iv) comparing the respective intensities of said reflected or transmitted radiation at said wavelengths to obtain a characteristic ratio for said filter and

(v) comparing said ratio with the standard ratio for the filter to check the authenticity of the article.

In a preferred embodiment, the electromagnetic radiation comprises at least one wavelength component which corresponds to a maximum in the spectral characteristic of the filter. Preferably, the electromagnetic radiation also comprises at least one wavelength component which corresponds to a minimum in the spectral characteristic of the filter.

According to another aspect of the invention, a method for covertly marking an article and checking its authenticity comprises the steps of:-

(i) applying an optical filter to the genuine article, wherein said filter has a spectral characteristic comprising at least one maximum and at least one minimum, and has a neutral appearance when observed under normal lighting conditions,

(ii) illuminating the article to be authenticated with electromagnetic radiation at two or more angles of incidence wherein said radiation comprises components of at least one wavelength,

(iii) upon said illumination, detecting radiation reflected or transmitted by the article to be authenticated at each angle of incidence,

(iv) comparing properties of the reflected or transmitted radiation at each angle of incidence with known properties of radiation reflected or transmitted by the filter at said angles of incident radiation.

Preferably, the spectral characteristic of the filter has a plurality of maxima and minima.

The spatial distribution of reflected or transmitted radiation may be compared with a known spatial distribution of radiation reflected or transmitted by the filter at said angles of incident radiation. Alternatively, the intensity of the reflected or transmitted radiation may be compared with known intensity of radiation reflected or transmitted by the filter at said angles of incident radiation.

The filter may be illuminated with electromagnetic radiation having wavelength components corresponding to spectral bands in the spectral characteristic of the filter.

Radiation having wavelength components corresponding to spectral bands in the spectral characteristic of the filter may be generated by placing a second filter in front of a radiation source, wherein said second filter has the spectral characteristic of the optical filter applied to the genuine article.

The filter for use in the invention may be incorporated in a label which is applied to the genuine article. Alternatively, the filter may be incorporated in a paint or may be deposited on a polymer film which is then subsequently applied to the genuine article.

The filter may be derived from a plurality of components, the components being deposited on layers of polymer film which are subsequently laminated together to produce the filter.

The filter may be distributed on a label in the form of a bar code.

A filter for use in any of the preceding claims comprises of:-

(i) a multi layer stack having at least one maximum and at least one minimum in the spectral characteristic and

(ii) a selective absorber over a range of visible wavelengths,

whereby the filter has a neutral appearance when observed under normal lighting conditions but gives rise to characteristic optical effects when illuminated with radiation having selected wavelength components.

The invention will now be described, by example only, with reference to the accompanying drawings in which :-

Figure 1 illustrates, schematically, the use of the current invention (a) in reflection mode and (b) in transmission mode and

Figures 2, 3 and 4 show the spectral characteristics of three typical filters which may be incorporated in the invention.

Referring to Figure 1(a), the article to be authenticated 1 is marked with label 2 incorporating an optical filter with a known spectral characteristic. During operation, label 2 is irradiated with radiation 3a from an electromagnetic radiation source 4 and the intensity of reflected radiation 3b, at two or more wavelengths, is measured by detector 5. Radiation source 3 might comprise of a laser array, a light emitting diode array or a filtered lamp and is such that the radiation incident on the label comprises two or more component wavelengths. For example, a tungsten lamp with a filter mounted in front to transmit only certain wavelength components may be used.

The article 1 to be authenticated may transmit incoming radiation, for example a glass bottle or container. In an alternative configuration, radiation transmitted by the label 2 may therefore be detected by placing the detector 5 on the opposite of the article from the radiation source 3, as shown in Figure 1(b).

Detector 5 is a detection system or a camera sensitive to the range of wavelength components corresponding to the wavelengths of the reflected (or transmitted) radiation. For example, a suitable detection means would be a CCD detector array. A lens 6 is also required in this arrangement to focus the radiation 3b onto the detector 5.

In any of the following examples, the methods described may apply to either the measurement of radiation reflected or transmitted by the filter.

Referring to Figure 2 , the spectral characteristic (reflectance versus wavelength curve) shown corresponds to a filter incorporated beneath a polychromatic black dye with an absorption edge at 700 nm. When the filter is viewed under normal lighting conditions it has a neutral appearance and appears black. The filter may also be designed to appear, for example, white, grey or silver. The filter has a reflectance peak 5, providing a narrow reflection band in the infrared wavelength region. If a monochromatic light source, with a wavelength corresponding to that of peak 7, is used to irradiate the filter, the reflected radiation can be measured by an observer by means of an infrared detector, sensitive to 850 nm. No visible optical effect would be observed by the eye and so the system may be operated covertly.

If a second source is used, emitting radiation with a wavelength corresponding to a minimum 8 in the spectral characteristic, and a second detector is used which is sensitive to this radiation, the ratio of the respective intensities of the two detector outputs provides a unique signature for the filter. Such a concept could be extended to include a multiple number of incident wavelengths or a multiple number of detectors, each sensitive to radiation at a different incident wavelength. The intensity at one or more maximum and minimum in the spectral characteristic may then be measured.

Referring to Figure 3, the spectral characteristic shown corresponds to a transmission filter (e.g. a Fabry Perot etalon) of the type $(HL)^2HH(LH)^2$ where H and L indiHcate materials of high and low refractive index respectively and each layer is a quarter-wave thick at the design wavelength. In this example, the design wavelength is the wavelength at the minimum 10 in the spectral characteristic. The materials H and L might be TiO_2 and SiO_2 respectively. The construction of such filters would be conventional to one skilled in the art.

In this example, the filter is formed on top of a broadband absorber (e.g. carbon based ink) and covered by a polychromatic black dye, as in the previous example. Under normal lighting conditions the filter would therefore have a neutral appearance and appears black. When illuminated with radiation having selected wavelength components, corresponding to the wavelength region of interest in the spectral characteristic, the filter gives rise to optical effects which may be used as a means of identification.

The spectral characteristic has a maximum 9 at 800 nm, a minimum 10 at 850 nm and has an absorption band 11 extending throughout the lower wavelength region. By illuminating the filter with radiation comprising wavelengths at 800 nm and 850 nm, and using detectors sensitive to said wavelengths, a comparison of the respective intensities of the two detector outputs provides a ratio characteristic of the filter. This can be compared to the known standard ratio for the filter to check the authenticity of the article.

Referring to Figure 4, the spectral characteristic 12 of the filter comprises a series of maxima 13 and minima 14 distributed throughout the visible wavelength region. The spacing of the maxima and minima (reflection bands) is chosen such that the filter has a neutral appearance when viewed in reflection under normal lighting conditions. For example, the filter may appear grey, white or black, depending on the design. The characteristic shown in Figure 4 corresponds to a Bragg reflector with the multi layer stack structure $(20LH)^6$, i.e. 20 layers of L material and 1 layer of H material arranged in a 6-period stack. Each layer is a quarter-wave thick at the design wavelength. For this example, the design wavelength would be considerably greater than the range covered in Figure 4 (i.e. greater than 700 nm). The construction of such reflectors would be conventional to one skilled in the art. Other variations of this reflector may also be used, particularly those based on a metallic-dielectric design.

As in the previous examples, a measure of the reflected (or transmitted) intensities at wavelengths corresponding to one or more maximum and minimum in the spectral characteristic 12 provides an authenticating signature for this particular filter.

Such a concept could also be extended to include a multiple number of incident wavelengths or a multiple number of detectors, each sensitive to radiation at a different incident wavelength. For example, the filter may first be illuminated with a series of wavelengths corresponding to the maxima 13 in the spectral characteristic 7 and then with a series of wavelengths corresponding to the minima 14. The integrated intensities measured when the filter is illuminated with the maxima wavelengths are then compared with the integrated intensities measured when the filter is illuminated with the minima wavelengths to give a characteristic ratio for the filter. If the required ratio is not measured, the article does not have the authenticating filter applied.

The intensity measurements may be made, for example, using a CCD detector array having a linear variable filter bonded to the front surface of the array to measure the intensities at each individual wavelength of interest. Alternatively, a multiple number of detectors, each sensitive to radiation at a different wavelength, could be used.

The wavelength components of the incident radiation need not correspond exactly to a maximum or minimum in the spectral characteristic, although preferably they correspond to spectral bands in the reflectance-wavelength curve (see Figure 4). For example, referring to Figure 2, the incident radiation might comprise wavelength components corresponding to 15 and 16. In this case, the detection system used would be sensitive to these wavelength components. A measure of the respective intensities at wavelengths 15 and 16 provides a characteristic ratio for the filter, even though the maximum and minimum reflectance is not detected.

In any of the examples, the radiation source (or sources) need not emit only discrete wavelengths, but a source may be used which emits radiation over a range of wavelengths such that the range encompasses the wavelength region of interest in the spectral characteristic.

The variation of the reflected intensity with the angle of incidence of the illuminating radiation may also be used as a distinguishing feature. For example, referring to the spectral characteristic shown in Figure 4, when interrogated using a source at 532 nm (corresponding to a maximum 13 in the spectral characteristic 12), the reflectance will decrease as the angle of incidence is changed. This effect would be visible to the eye as the article to be protected is tilted before the observer. If a second source at, for example, 633 nm was used (corresponding to a minimum 14 in the spectral characteristic 12), the reverse effect would be seen and the reflected intensity would increase as the object was tilted.

The effect can be quantified by the use of suitable detectors. A comparison of the measured intensities at the selected angles with the known intensities at these angles for the filter may then be used to provide a further means of checking the authenticity of the filter.

Alternatively, the spatial distribution of the reflected (or transmitted) radiation, as modified by the filter, may be used as a signature of authenticity. In a preferred arrangement, a radiation source having a plurality of wavelength components may be used, for example a filtered tungsten lamp, where radiation emitted from the lamp passes through a filter having the construction of that of the example in Figure 4 (i.e. $20(HL)^6$). Only selected wavelength components are therefore incident on the optical filter, in this case corresponding to the maxima and minima in the spectral characteristic. Upon tilting the filter (or the article to which the filter is applied) the change in reflectance will be observed by the human eye. When the article is illuminated with radiation from the lamp and filter combination, an informed operator aware of the authenticating optical effect may use the observed optical effect as a means of verifying the authenticity of the article.

Conveniently, a range of angles may be assessed by illuminating the article with a spatially extended radiation source and tilting it with respect to a fixed detector. Alternatively, the angular signature may be determined as the article (for example, a credit card) is passed through a reader, wherein the reader is fitted with the suitable radiation source and detectors in a fixed arrangement, giving a fixed geometrical relationship to the article.

The concept of using the tilting of the filter to provide the required authentication signature could also be extended outside the visible wavelength region using a suitable radiation source (or sources) and suitable detection means, such as a camera.

The design of the filter can be adjusted to allow its use with any convenient wavelength of light by the definition of the design wavelength and the selection of the order parameter m in $(mLH)^n$ or $(mHL)^n$. In this case, the number of pairs of layers, n, in the Bragg reflector defines the contrast level achieved at the maximum of the reflection band.

The filter may be used on a surface, either alone or in conjunction with absorbing, to produce suitable reflection characteristics. The features of the filter (or label) applied to the article may be incorporated into various visible features of the article, for example a trademark, a surface decoration or a bar code.

If the filter is distributed on the label in the form of a bar code, one or more different spectral characteristics can be used for different lines in the bar code pattern. The filters would be designed to be equivalent when viewed in daylight or tungsten light, so that all lines in the bar code would be equally intense to the observer or camera. When viewed with the correct illuminating wavelengths, differences are seen by the observer or camera, therefore providing an additional level of security in the bar code.

The filter to be incorporated into a label may be realised in the form of a paint, by incorporating flakes of the filter into a suitable binder, therefore allowing ease of application. Alternatively, the layers which make up the filter may be deposited on a polymer film which is then applied to the article. Filters with a small number of maxima and minima in the reflectance curve may be deposited on to a series of such films and then laminated together in different combinations. This provides a convenient means of continuously varying the characteristics of the filters used.

Claims

1. A method for covertly marking an article and checking its authenticity comprising the steps of:-

(i) applying an optical filter to a genuine article, wherein said filter has a spectral characteristic comprising at least one maximum and at least one minimum, and has a neutral appearance when observed under normal lighting conditions,

(ii) illuminating the article to be authenticated with electromagnetic radiation comprising components of at least two wavelengths,

(iii) upon said illumination, detecting radiation reflected or transmitted by the article to be authenticated and

(iv) comparing the respective intensities of said reflected or transmitted radiation at said wavelengths to obtain a characteristic ratio for the filter and

(v) comparing said ratio with the standard ratio for the filter to check the authenticity of the article.

2. The method of claim 1 where the electromagnetic radiation comprises at least one wavelength component which corresponds to a maximum in the spectral characteristic of the filter.

3. The method of claim 1 where the electromagnetic radiation comprises at least one wavelength component which corresponds to a minimum in the spectral characteristic of the filter.

4. A method for covertly marking an article and checking its authenticity comprising the steps of:-

(i) applying an optical filter to the genuine article, wherein said filter has a spectral characteristic comprising at least one maximum and at least one minimum, and has a neutral appearance when observed under normal lighting conditions,

(ii) illuminating the article to be authenticated with electromagnetic radiation at two or more angles of incidence, wherein said radiation comprises components of at least one wavelength,

(iii) upon said illumination, detecting radiation reflected or transmitted by the article to be authenticated at each angle of incident radiation and

(iv) comparing properties of the reflected or transmitted radiation at each angle of incident radiation with known properties of radiation reflected or transmitted by the filter at said angles of incident radiation.

5. The method of claim 4 wherein the spectral characteristic of the filter has a plurality of maxima and minima.

6. The method of claim 5 wherein the spatial distribution of reflected or transmitted radiation at said angles of incident radiation is compared with the known spatial distribution of radiation reflected or transmitted by the filter at said angles of incident radiation.

7. The method of claim 5 wherein the intensity of the reflected or transmitted radiation at said angles of incident radiation is compared with the known intensity of radiation reflected or transmitted by the filter at said angles of incident radiation.

8. The method of claims 4-7 wherein the filter is illuminated by electromagnetic radiation having wavelength components corresponding to spectral bands in the spectral characteristic of the filter.

9. The method of claim 8 wherein electromagnetic radiation having wavelength components corresponding to spectral bands in the spectral characteristic of the filter is generated by placing a second filter in front of a radiation source, wherein said second filter has the spectral characteristic of the filter applied to the genuine article.

10. The method of any of the preceding claims wherein the filter to be applied to the genuine article is incorporated in a label which is applied to the genuine article.

11. The method of claim 10 where the filter to be applied to the genuine article is incorporated in a paint which is subsequently applied to the genuine article.

12. The method of claim 10 where the filter to be applied to the genuine article is deposited on a polymer film which is subsequently applied to the genuine article.

13. The method of claim 12 where the filter to be applied to the genuine article is derived from a plurality of components, the components being deposited on layers of polymer film which are subsequently laminated together to produce the said filter.

14. The method of any of the preceding claims wherein the filter to be applied to the genuine article is distributed on a label in the form of a bar code.

15. A filter for use in any of the preceding claims comprising:-

(i) a multi layer stack having at least one maximum and at least one minimum in the spectral characteristic and

(ii) a selective absorber over a range of visible wavelengths,

whereby the filter has a neutral appearance when observed under normal lighting conditions but gives rise to characteristic optical effects when illuminated with radiation having selected wavelength components.

Fig.1(a).

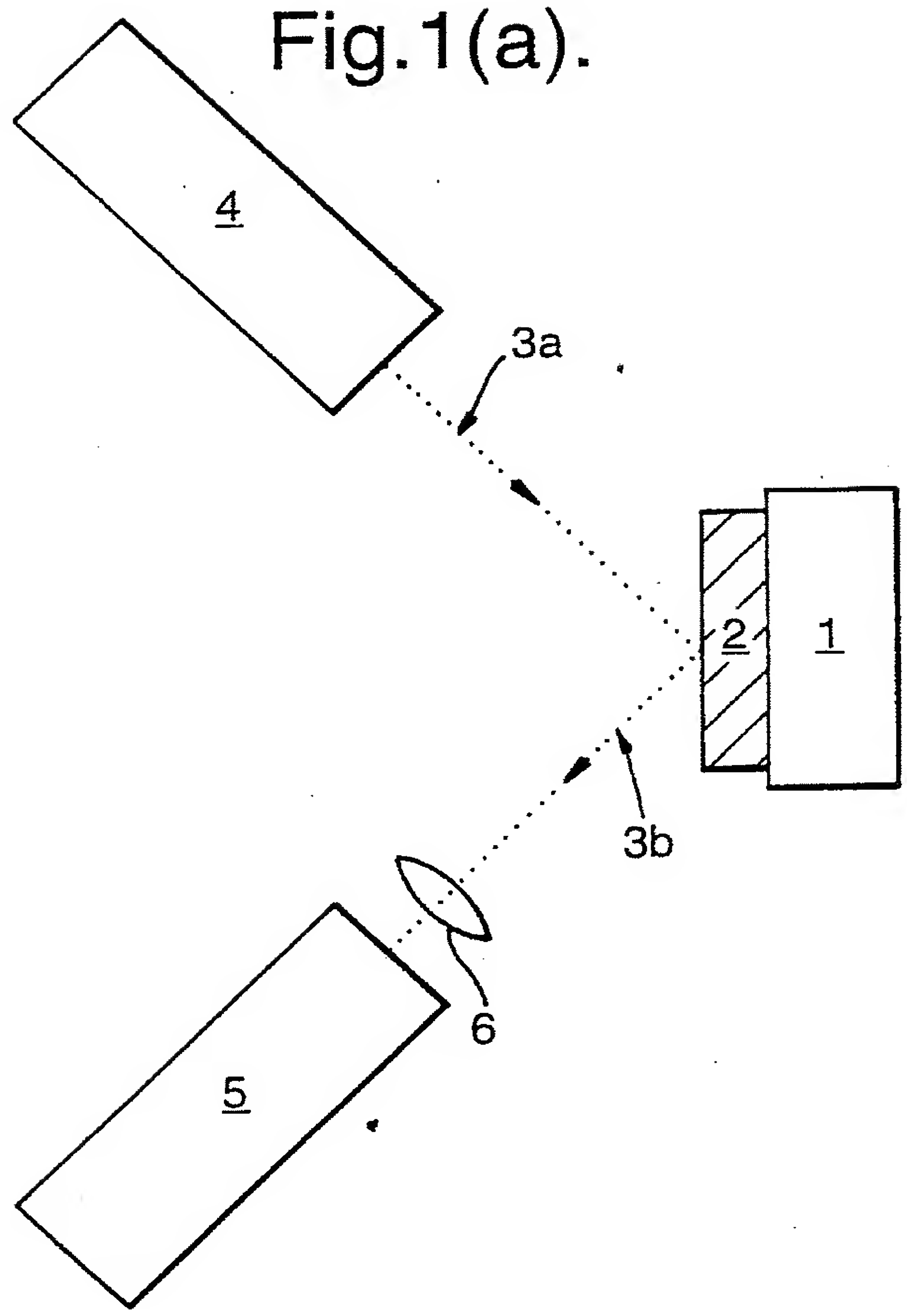


Fig.1(b).

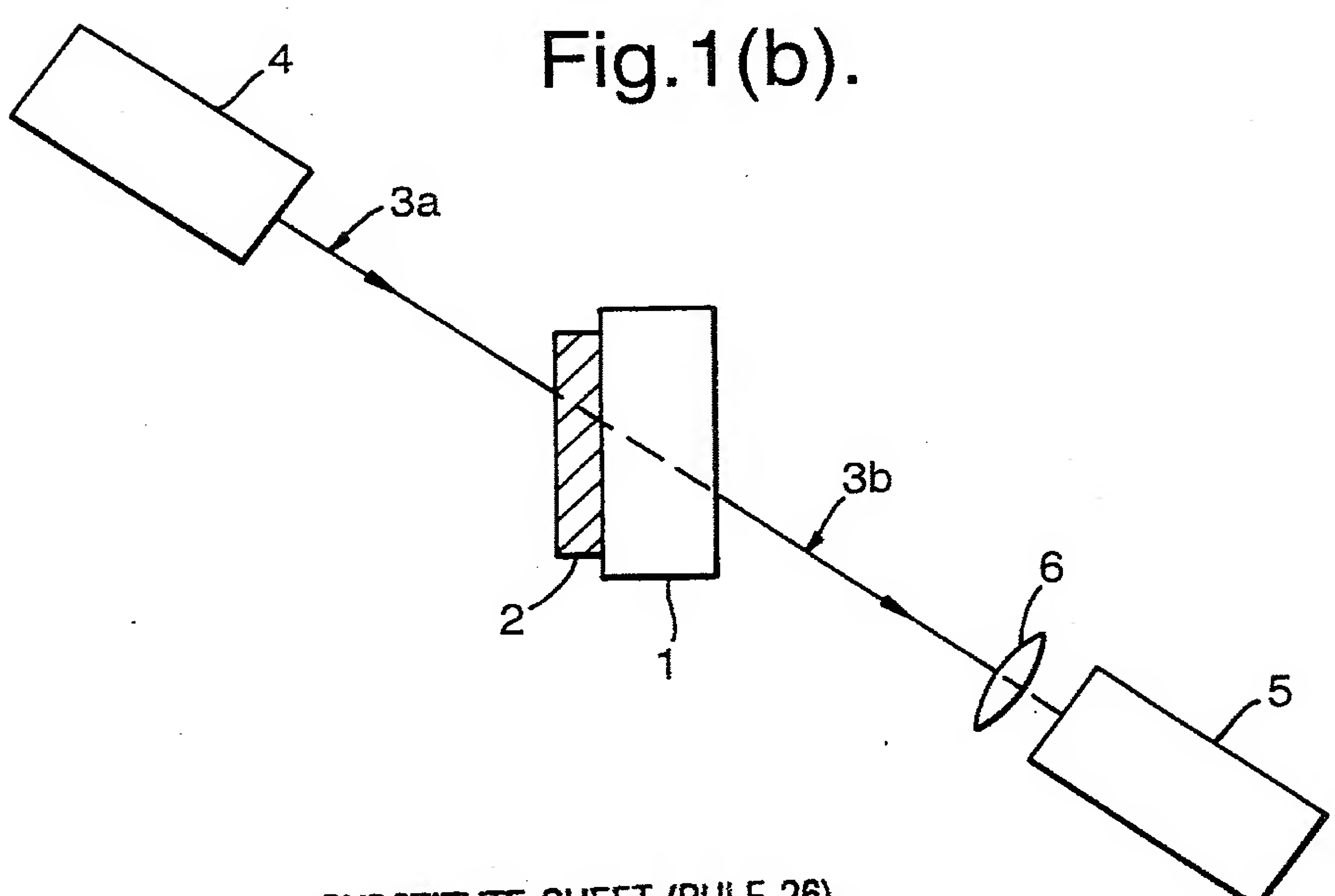
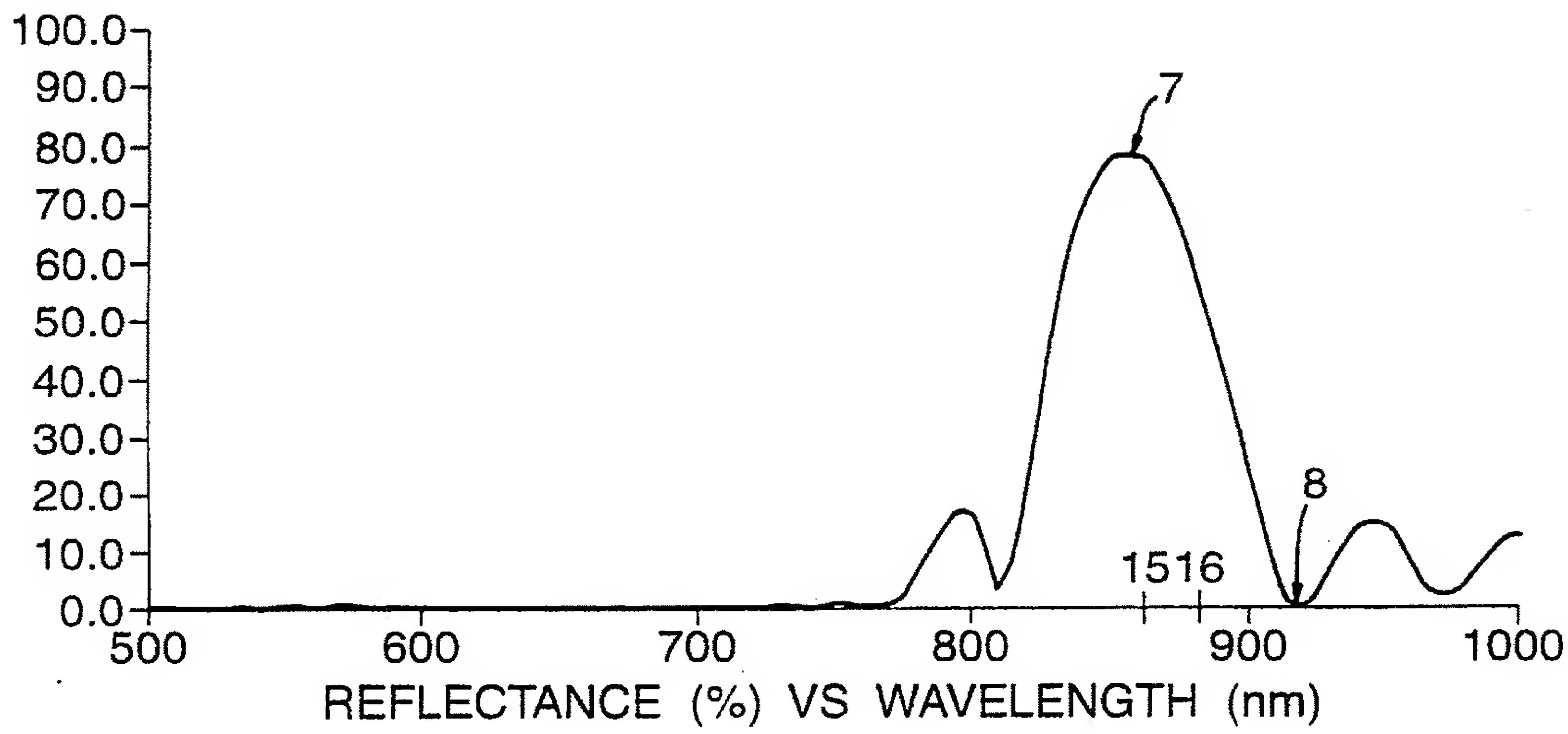


Fig.2.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REFLECTANCE (%) VS WAVELENGTH (nm)

Fig.3.

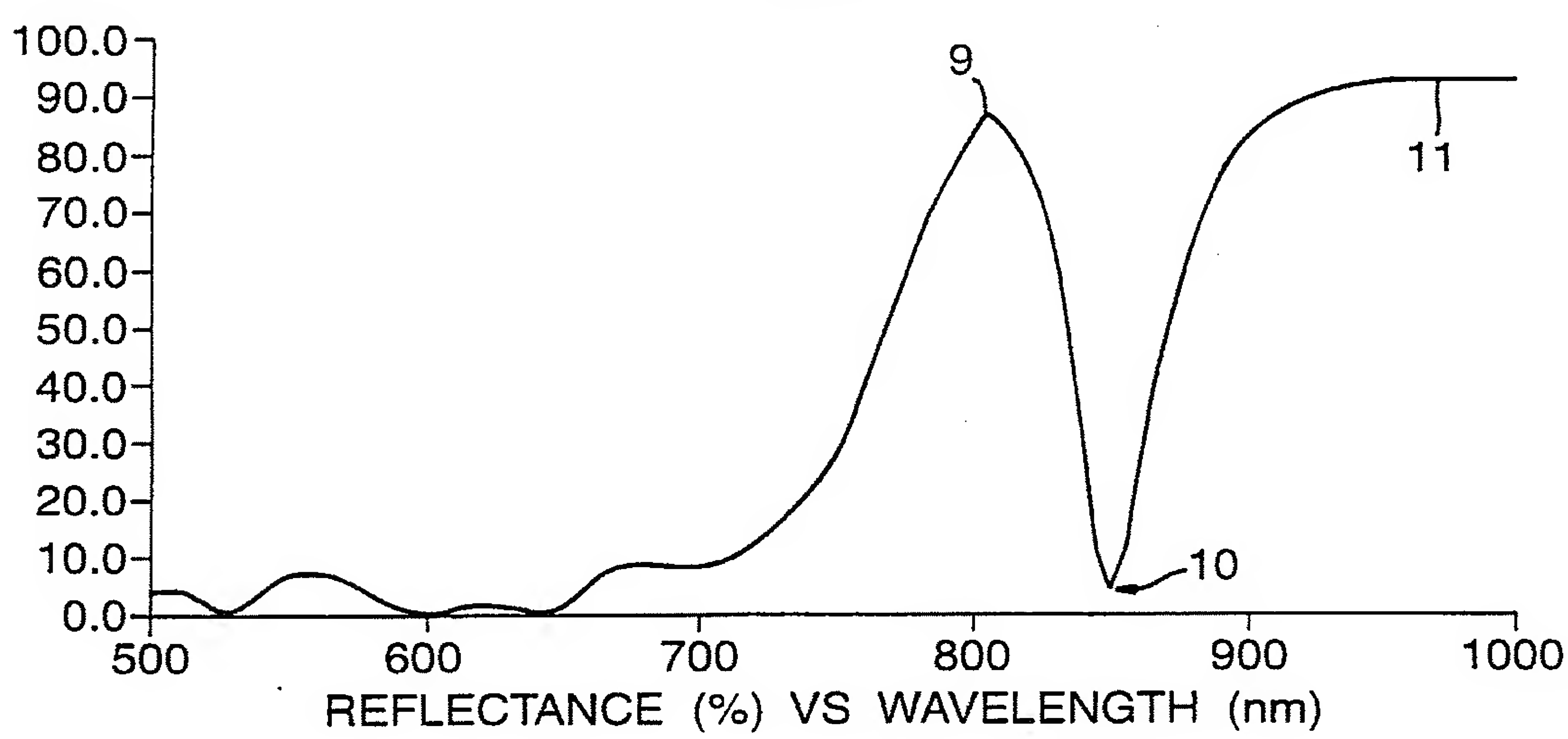
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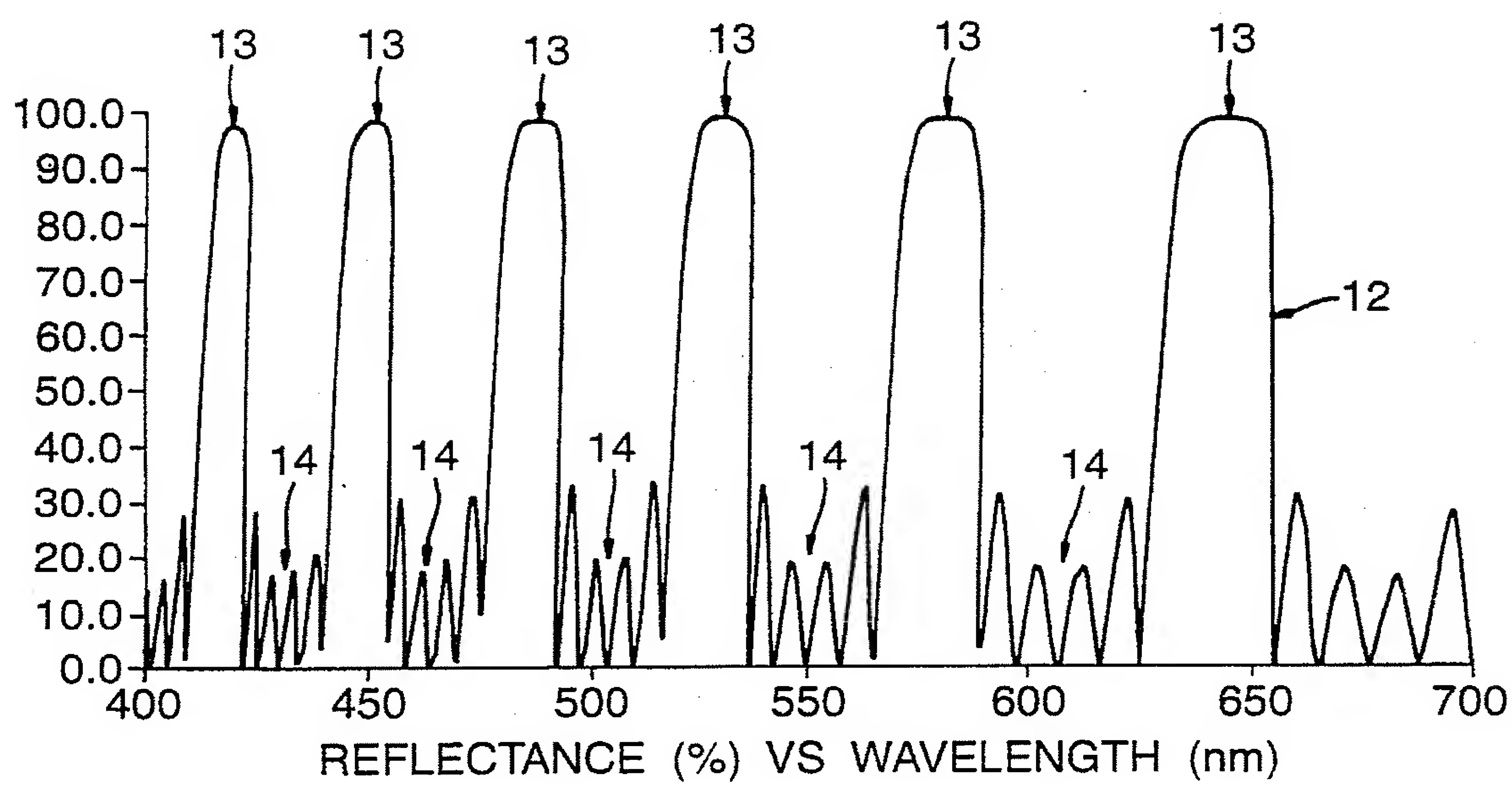
Fig.4.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REFLECTANCE (%) VS WAVELENGTH (nm)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/01469

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G07D7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G07D G06K G07F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 407 005 A (EMI PLC THORN) 9 January 1991	1,4,15
A	see claim 1; figures 2,6	2,3,5-14
A	EP 0 253 089 A (LANDIS & GYR AG) 20 January 1988 see claim 1; figure 3C	1-15
A	US 4 359 633 A (BIANCO JAMES S) 16 November 1982 see claim 1; figure 1	1-15
A	US 4 824 144 A (TASMA GERALD W) 25 April 1989 see claim 1; figure 1	1-15
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[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 September 1996	31. 10. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kirsten, K

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INTERNATIONAL SEARCH REPORT

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PCT/GB 96/01469

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 568 185 A (NHK SPRING CO LTD) 3 November 1993 see claim 1; figure 4 -----	1-15

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Information on patent family members

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PCT/GB 96/01469

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US-A-4824144	25-04-89	NONE		
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